

intention to make an extended investigation of the bodies belonging to the hexyl group, which are very imperfectly known, as may be inferred from the fact that Faget, the discoverer of hexylic alcohol, has not even published its analysis.

XV. "The Lignites and Clays of Bovey Tracey, Devonshire."

By WILLIAM PENGELLY, Esq., F.G.S. Communicated by
Sir CHARLES LYELL. Received November 16, 1861.

(Abstract.)

The village of Bovey Tracey, in Devonshire, is situated on the left bank of the river Bovey, a small tributary of the Teign, about eleven miles south-westerly from Exeter. A considerable plain stretches away from it, for about nine miles, in a south-easterly direction, and terminates three and a half miles north-west of Torquay. It appears a lake-like expansion of the valleys of the Bovey and Teign, and is surrounded on all sides by lofty hills of granite and other rocks.

Excavations in various parts of this plain, especially in the north-western part of it, known as Bovey Heathfield, have disclosed, beneath an accumulation of gravel mixed with clay and sand, a regular series of strata of lignite, clay and sand, well known to geologists as the "Bovey deposit," whilst the lignite is equally familiar as "Bovey coal."

The most important of the excavations is that known as the "Coal-pit," whence lignite is extracted, which is used, in small quantities, at a neighbouring pottery, and also by the poorer cottagers of the immediate neighbourhood.

The deposit has long attracted the attention of both the scientific and commercial world, and many authors have given descriptions and speculations respecting it.

In 1760 the Rev. Dr. Jeremiah Milles sent a paper on it to the Royal Society. His aim appears to have been to prove the *mineral* origin of the lignite, in refutation of Professor Hollman, of Göttingen, who had described, and assigned a vegetable origin to, a similar substance found near the city of Munden. In 1794 and 1796 Dr. Maton described the deposit, and mentioned the existence of a large turf bog, near the pit, in which whole trees were often discovered,

but "none of them bearing the least resemblance to Bovey coal." In 1797 Mr. Hatchett brought the subject before the Linnean Society, in a paper in which his object seems to have been the refutation of the mineral theory of Dr. Milles. In his 'History of Exeter,' published in 1802, Mr. Brice next gave an account of the deposit, and the state of the lignite workings; he supposed the basin to have formerly been a stagnant lake or morass into which trees were successively transported from the neighbouring slopes. The twelfth letter in Parkinson's 'Organic Remains,' published in 1804, appears to have been written by Mr. Scammell, of Bovey Tracey, and is devoted to the lignite; from it we learn that the coal had been worked upwards of ninety years, and that the trees found in the bog, mentioned by Dr. Maton, were of the fir kind. Mr. Vancouver, in his 'General View of the Agriculture of the County of Devon,' published in 1808, supposes the lignite to have been the product of pine forests which grew where it is found, and that clay and other moveable matter must have been poured over them, in a fluid state, at different periods, from the craggy eminences around. Mr. Austen, in his 'Memoir on the Geology of the South-east of Devonshire,' states that the Bovey beds rest on a gravel equivalent to the lowest tertiary deposits, and is thus the first writer who addresses himself to the chronology of the formation. He makes the overlying gravels post-tertiary, but belonging to the "period prior to the most recent changes of relative level of land and water and of climate." Sir H. De la Beche, in his 'Report of Cornwall, Devon, &c.,' expresses surprise and regret that, excepting the lignite itself, no organic remains have been detected in the deposit, so that we are deprived of any aid by which it may be referred to any particular geological date; and adds that "if the wood be, as has been supposed, analogous to oak and other existing trees, we should suppose the Bovey beds to have been formed towards the latter part of the supracretaceous period." In 1855, Dr. Hooker read a paper before the Geological Society of London, "On some Small Seed-vessels (*Folliculites minutulus*) from the Bovey Tracey Coal," which was the first announcement of the discovery of identifiable fossils in the deposit. Besides the fossil just named, Dr. Hooker described a cone of the Scotch fir, *Pinus sylvestris*, said to have been found in one of the uppermost beds of lignite, and from it he came to the provisional conclusion that the

Bovey beds belong to the Post-Pliocene epoch. In 1856, Dr. Croker, of Bovey Tracey, sent to the same Society a paper in which he mentioned the occurrence of large "flabelliform leaves," together "with tangled masses of vegetable remains in some of the higher beds."

In 1860 Sir Charles Lyell and Dr. Falconer visited Bovey, and returned with the impression that the formation belonged to the miocene age. The latter introduced the subject to Miss Burdett Coutts as one which it was eminently desirable to have fully and carefully investigated. Miss Coutts having soon after visited the district with the author, requested him to undertake an investigation of the deposit, which he accordingly did; and at once engaged Mr. Keeping, the well-known and experienced fossil collector of the Isle of Wight.

Sections of the deposit at the coal-pit show a series of beds naturally dividing themselves into three parts, namely,—

1st, or uppermost, a bed of sandy clay, containing large angular and subangular stones, chiefly of Dartmoor derivation, unconformably covering the lower beds. No stones occur below this.

2nd. A series of twenty-six beds of lignite, clay and sand, the base of which is a bed of ferruginous quartzose sand, in some places 27 feet thick, in others less than one foot, but which everywhere occurs as a well-marked feature in the pit-sections. Excepting this bed, sand is almost entirely confined to the uppermost part of the division.

3rd. A set of forty-five beds of regularly alternating lignite and clay.

The stones by which it is characterized, and its unconformability, show that the uppermost division could not have been formed under the same conditions, nor probably in the same geological period as the two lower series. This view has been confirmed by the identification of certain fossil leaves found in the clays of the uppermost series.

The two lower series are strictly conformable, and dip $12\frac{1}{2}^{\circ}$ towards S. 35° W. (mag.). Five beds,—one of clay and four of lignite,—in the second series, and nine,—one of clay and eight of lignite—in the lower, a total of fourteen, have yielded fossils, all of them remains of plants only. A few only of these beds require particular mention. The seventh bed is, in many places, a mat of the debris of a coniferous tree, the *Sequoia Couttsiæ*, and fronds of

ferns, chiefly *Pecopteris lignitum*. The seventeenth bed contains a large number of dicotyledonous leaves. The twenty-fifth is that in which the so-called "flabelliform leaves" of Dr. Croker occur; they have been decided to be large rhizomes of ferns. The twenty-sixth, a bed of clay, is richer than any other in the number and variety of its fossils, which consist of dicotyledonous leaves, seeds of various kinds, and débris of Sequoia stems, leaves, fruits, and seeds. Remains of the last occur, in well-marked specimens, in the fortieth and sixty-third beds; so that it ranges throughout the formation, both divisions of which, therefore, belong to one organic period. The forty-sixth bed abounds in the seeds described by Dr. Hooker as *Folliculites minutulus*, but which Professor Heer has recognized as *Carpolithes Kaltennordheimensis*.

The lignite has frequently a "charred" appearance, and it is difficult to believe that it has not undergone true combustion in the beds, the ignition being spontaneous.

Coal has been found upwards of 170 feet below the surface of the plain, and there are reasons for believing that the deposit is fully 300 feet in depth.

On the advice of Dr. Falconer, the fossils have been submitted to Professor Heer of Zürich, who has found amongst them 49 species of plants, eight of which were found by himself during a personal investigation of the deposit. Many of these are entirely new to science, whilst the others are well known as continental representatives of the lower miocene age. In addition to these, four species have been identified in the uppermost, or gravel division, as belonging to the diluvial period, "that is, a period when the climate of Devonshire was colder than at present."

The deposit is eminently freshwater, and must have been formed in a lake, the bottom of which is, at present, at least 30 fathoms below the level of ordinary spring tide high water. It appears probable that the waters of this miocene lake were separated from the ocean by a barrier which crossed the present tidal estuary of the Teign, and over this the surplus waters passed to the sea; or that they formed a lower outlet in the valley between Newton and Torquay; the first seems, from the physical characters of the two valleys, to have been the most probable course. During the investigation a search was made for fossils at the clay-works of Aller,

Kingsteignton and Decoy, all near Newton Abbot; nothing was found except at the last place, where a stem of *Sequoia Couttsie* was met with, thus showing that the deposit is identical with that at Bovey Heathfield.

XVI. "The Fossil Flora of Bovey Tracey." By Dr. OSWALD HEER, Professor of Botany and Director of the Botanical Gardens in Zürich. Communicated by Sir CHARLES LYELL.

(Abstract.)

The surface-covering of the Bovey plateau consists of a light-coloured quartzose sand, which contains here and there considerable beds of white clay. By the plants contained in it this formation is assigned to the Diluvium.

Immediately under it come the beds of clay and lignite, which belong to one formation, far older than that of the overlying white clay; the plants found in them determine them as belonging unquestionably to the miocene period. Hence the formations must be treated of separately.

A. *The Miocene Formation of Bovey.*

Of the forty-nine species of plants hitherto discovered in the lignite beds of Bovey, twenty occur on the Continent in the miocene formation. Those beds are therefore undoubtedly miocene. When tabulated, it is seen that fourteen of the twenty species occur in the Tongrien étage, thirteen in the Mayencien, five in the Helvétien, and eight in the Æningien; hence the Bovey lignites must be ranged in the under miocene, and in the Aquitanien étage of it.

Moreover, the *new* species at Bovey are closely allied to well-known continental forms on this horizon.

It is remarkable that Bovey has no species in common with Iceland, although the tertiary flora of the latter belongs to the same period, and two of its species have been found in the miocene deposit of Ardtun Head in Mull. The Bovey flora has a much more southern character, manifesting, indeed, a sub-tropical climate.

It has certainly some points of connexion with the eocene of the Isle of Wight, but on the whole possesses an essentially different character. The fact that but one species is common to it and Alum Bay, whilst it has so many in common with the more remote miocene